

An Assessment of the Ladkrabang Industrial Estates in Bangkok, Thailand

United States-Asia Environmental Partnership

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
BACKGROUND	8
Environmental Legislation and Regulation	8
Industrial Estates Authority of Thailand	8
PROGRAM DESCRIPTION	9
DESCRIPTION OF ACTIVITIES	10
GENERAL RECOMMENDATIONS	14
SPECIFIC RECOMMENDATIONS	18
A. Industrial Estate Management Recommendations	18
B. Wastewater Observations and Recommendations	20
C. Hazardous Waste/Solid Waste Observations and Recommendations	21
D. Air Observations and Recommendations	23
CONCLUSION	26
ATTACHMENT I Memorandum of Understanding with the Industrial Estates Authority of Thailand	27
ATTACHMENT II Work Plan for the Ladkrabang Industrial Estate Remediation Project.....	28
ATTACHMENT III Comparison of Air Quality Standards	30

List of Acronyms

ARB	California Air Resources Board
BOD	biologic oxygen demands
Cal/EPA	California Environmental Protection Agency
CEP	California Environmental Partnership
COD	chemical oxygen demands
EMS	environmental management system
GENCO	General Environmental Conservation Public Company Limited
IE	industrial estate
IEAT	Industrial Estates Authority of Thailand
ISO 14000	International Organization of Standardization 14000
MOI	Ministry of Industry (Thailand)
MOSTE	Ministry of Science, Technology and Environment (Thailand)
MOU	memorandum of understanding
NEB	National Environmental Board (Thailand)
NEQA	National Environmental Quality Act of 1992 (Thailand)
US-AEP	United States-Asia Environmental Partnership
US EPA	United States Environmental Protection Agency
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

In July 1996, a state/federal partnership was established that includes the United States Agency for International Development-led program called the United States-Asia Environmental Partnership (US-AEP), the California Environmental Protection Agency (Cal/EPA), and the California Trade and Commerce Agency. This three-member partnership, titled the California Environmental Partnership (CEP), was established to assist Asian governments in solving environmental problems and to increase environmental technology transfer in the international marketplace. CEP assists Asian governments by deploying technical assistance teams to Asia.

A significant step occurred in 1997 when CEP signed a memorandum of understanding (MOU) with the Industrial Estates Authority of Thailand (IEAT) to develop a long-term environmental program to provide technical assistance and promote the transfer of clean environmental technologies. A copy of the MOU is presented in Attachment I.

Under the MOU, IEAT's first request for assistance was to address waste management issues at the Ladkrabang Industrial Estate (IE) in Bangkok. Project activities included a preliminary visit and an environmental assessment of Ladkrabang, a review of available technology solutions and recommendations for improvements. During the week of November 17 - 25, 1997, an initial reconnaissance trip was made to the Ladkrabang IE to determine the extent of environmental issues, to design a Cal/EPA team to meet those needs, and to make preliminary recommendations.

In response to IEAT's request for technical assistance, CEP assembled a four-person team to provide a comprehensive multimedia environmental assessment of the Ladkrabang IE from February 2 - 13, 1998.

Team members were selected from Cal/EPA staff with expertise in the following disciplines:

Jennifer Smith Grub	International Organization of Standardization (ISO) 14000 and hazardous waste
Peter Ouchida	air quality
Teng-Chung Wu	water quality
Astrid Johnson	hazardous substances

Solid waste expertise is shared among the four team members.

The Ladkrabang IE is 20 years old and occupies approximately 1,000 acres of land. One hundred and ninety-two factories employing 57,000 employees are located on this industrial estate. Factories are involved in a variety of industrial production/manufacturing processes whose activities or products include car assembly, electronics, garments, furniture, rubber gloves, and pharmaceuticals. Products are manufactured for both domestic consumption and for exporting to overseas markets.

Recommendations

As a result of its two-week assessment, the Cal/EPA team developed a variety of recommendations that cover each of the six disciplines. A more detailed discussion of these recommendations can be found in the Recommendations Section. Some of the recommendations are as follows:

General Recommendations

1. Develop an ISO 14000 environmental management system (EMS). ISO 14000 provides a comprehensive approach to environmental problem solving by implementing an environmental management system which addresses multimedia needs.
2. Establish a working group of representatives from IEAT, industry, and non-governmental organizations to develop the EMS. The objective would be to develop an EMS that (a) identifies the effects of industrial activities and commercial products upon the environment, and (b) implements strategies for long- and short-term solutions to more effectively manage the estate.
3. Establish pollution identification and prevention programs involving community members.
4. Establish consensus agreements for ensuring compliance. Create an assessment procedure for IEAT inspectors and industry to use that includes a plan to monitor for compliance. Establish pollution prevention agreements and include the assessment procedure.
5. Establish a material accountability program for the estate. Environmental management programs should encourage companies to sort, classify, and recycle non-hazardous solid wastes as a means of recovering a material's re-use value or energy content that is lost when discarded rather than recycled.
6. Increase IEAT staff at the Ladkrabang Industrial Estate and expand training opportunities for IEAT staff.

Specific Recommendations: Industrial Estate Management

7. Establish a clear management policy to support an environmental compliance program. A short- and long-term environmental management plan could be prepared and implemented. Establishing a more specific environmental management policy and plan would provide an opportunity to clarify the expectations from IEAT management.
8. Prepare a mission statement and develop a strategic plan, with time frames, on how to meet the goals of the mission statement. Involve the factories and IEAT staff from the beginning in developing and implementing the action plans.
9. Establish at least one environmental position for every 40 factories. Offer training and education programs for factories regarding legal obligations, pollution prevention, waste minimization opportunities, and ISO 14000.
10. Provide consultative services to factories regarding environmental issues, such as legal requirements and pollution prevention, by utilizing IEAT staff. Conduct periodic audits at each factory to ensure environmental policies are understood and being implemented properly.
11. Recognize the Ladkrabang IE managers for taking action at factories to ensure regulatory compliance and include this task as part of the employees' performance reviews. This would provide the managers with appropriate recognition for effectively applying environmental policies.
12. Establish centralized hazardous waste storage facilities. This would allow smaller quantity generators the opportunity to aggregate hazardous wastes in a common area until the hazardous waste disposal facility picks them up, thereby reducing the hazards of long-term on-site storage.
13. Develop a waste exchange program to encourage and promote recycling. Once the factories realize the economic benefit of recycling and exchanging wastes, they may be more receptive to participating in such a program.
14. Encourage formation of factory associations at the estates to increase communication between factories manufacturing the same products.
15. Develop a public participation program using IEAT staff that would allow the public to
 - a. access information regarding operations at the estates;
 - b. have input on new projects which may impact the environment; and
 - c. receive public information services regarding environmental issues such as legal requirements and pollution prevention.

16. Implement a hazardous waste shipping (e.g., manifest) tracking program to ensure proper handling and disposal of hazardous wastes.
17. Establish regular environmental coordination meetings between senior management of the Ministry of Industry; the Ministry of Science, Technology and Environment; the Ministry of Labor and Social Welfare; the Ministry of Public Health; universities and academics; and the Bangkok Metropolitan Administration to address common environmental concerns (e.g., training and education, auditing, and compliance).

Specific Recommendations: Wastewater

18. Develop and implement a comprehensive pretreatment and waste minimization program to reduce the discharge of metals and other toxic pollutants from the factories to the sewer system.
19. Repair broken sewers to reduce infiltration of extraneous water such as groundwater and rainwater. In addition, the sewer lines should be inspected to determine their integrity and to periodically remove obstructions.

Specific Recommendations: Hazardous Waste/Solid Waste

20. Analyze sludge from the wastewater treatment plants to determine whether it is hazardous and if so, dispose of it properly (through a disposal company like General Environmental Conservation Public Company Limited [GENCO]). As a temporary measure, dewatered sludge piles could be covered with tarps to prevent rainfall from creating contaminated leachate and polluting the waterway.
21. Develop a hazardous waste management plan. A system that would show the type of waste generated by each factory and its final destination would greatly benefit IEAT.

Specific Recommendations: Air

22. Collect comprehensive air-monitoring and meteorological measurements to determine the air quality for the entire Ladkrabang estate.
23. Use air emission factors for calculating estimated pollutant emissions and for establishing process operating permit conditions as an economic alternative to conducting source tests and stack monitoring.

24. Conduct an active stack-monitoring program on the estate to quantitate ducted emissions to the atmosphere. Such monitoring capabilities would be necessary to support air pollution compliance, emissions inventory, control technology evaluation, and research programs for air quality goals.

Thai cultural and social traditions do not seem compatible with a command-and-control type of regulatory method that is practiced in the United States. Pollution enforcement activities conducted by IEAT staff with companies on the estate follows a subtle tact that treads a delicate path between mutual trust and consensus to maintain a regulatory balance among business interests, employee wellness, public relations, and environmental protection.

An environmental management system emphasizing ISO 14000 consensus standards would be the most reasonable approach for the Ladkrabang IE to achieve environmental objectives in a culturally sensitive, efficient, and cost-effective manner. It would provide for mutual acceptance of environmental goals, acceptance of responsibility, and recognition of achievement in the environmental arena.

Specific follow up actions by Cal/EPA could include

- providing training in wastewater treatment, hazardous and solid waste issues, air issues, and ISO 14000 implementation; and
- a technology trade mission to Thailand with a Cal/EPA Team representative as a facilitator. California companies could provide consultative services and recommend applicable environmental technologies for IEAT as well as individual factories in order to upgrade current services and processes.

BACKGROUND

Environmental Legislation and Regulation

Thailand's environmental laws and regulations were recently revised to reflect the implementation of the Seventh National Economic and Social Development Plan (1992-1996). For the first time, this plan included enhanced environmental quality as an explicit goal.

The National Environmental Quality Act of 1992 (NEQA) increased the scope of pollution control, established criminal sanctions for violations, and created an Environment Fund. The Factories Act of 1992 empowered the Ministry of Industry (MOI) to regulate factories through the establishment of standards and procedures to control waste, pollution, and other activities which may harm the environment. The Hazardous Substances Act of 1992 obliged MOI to identify the types and specifications of hazardous substances. Interministry cooperation is expected between the Ministries of Defense, Agriculture, Interior, Public Health, and Science, Technology and Environment to supervise the committee on Hazardous Substances.

The National Environment Board (NEB) and the Ministry of Science, Technology and Environment (MOSTE) have both been instrumental in addressing environmental concerns. NEQA enhanced the powers of the NEB by empowering it to establish environmental quality standards for water, air, noise, and vibrations. NEB submits plans for the conservation of environmental quality to the Council of Ministers, which is the highest-level policy-making body in Thailand. NEB has the authority to enact air quality standards and oversee the implementation of environmental quality ministerial regulations. In October 1997, NEB decided that Thailand's 49 industrial estates and parks will be required to obtain ISO 14000 environmental management systems certification.

Industrial Estates Authority of Thailand (IEAT)

Within the Ministry of Industry, IEAT was established in 1972 as a semi-public government agency charged with fulfilling the government's industrial development policy with a specific objective to develop and ensure the orderly planned industrialization of individual industries and the country as a whole. Since that time, 29 industrial estates have been established which are either solely or jointly managed by IEAT.

An industrial estate resembles a town or city, complete with the infrastructure needed for industrial operations, such as electricity, water supply, public utilities, and environmental controls. An industrial estate is recognized as a "preferential treatment area" because investors are eligible for incentives and privileges, such as accommodations and facilities to conduct business, land development and improvement assistance, land use permits, building permits, and operating permits.

PROGRAM DESCRIPTION

IEAT first requested assistance under the MOU to address waste management issues at the Ladkrabang IE. Proposed project activities included a preliminary visit and environmental assessment of Ladkrabang, a review of available technology solutions, and recommendations for improvements. During the week of November 17 - 25, 1997, an initial reconnaissance trip was made to the Ladkrabang IE to determine the extent of environmental issues, to design a Cal/EPA team to meet those needs, and to make preliminary recommendations.

Based on the findings of the reconnaissance trip, the California Environmental Partnership (CEP) assembled a four-person team to provide a comprehensive multimedia environmental assessment of the Ladkrabang IE from February 2 - 13, 1998. Team members were selected from Cal/EPA staff with expertise in the following disciplines:

Jennifer Smith Grubb	ISO 14000 & hazardous waste
Peter Ouchida	air quality
Teng-Chung Wu	water quality
Astrid Johnson	hazardous substances

Solid waste expertise is shared among the four team members.

The Ladkrabang IE is 20 years old and occupies approximately 1,000 acres of land. Forty seven percent (47%) of the estate is designated a “general industrial area” and 27% an “export processing zone.” Products for domestic consumption are manufactured in, and transported out of, the general industrial area. Products for overseas markets are manufactured in the export processing zone. Materials/products entering and leaving this zone are monitored by custom officials headquartered on the industrial estate. Eighty-five factories employing 17,000 workers are located in the general industrial area, and 107 factories employing 40,000 people are located in the export processing zone. The factories are involved in a variety of industrial production/manufacturing processes whose activities or products include car assembly, electronics, garments, furniture, rubber gloves, and pharmaceuticals.

As at other estates, IEAT provides the infrastructure, such as a central wastewater treatment system, a solid waste treatment/disposal facility, a water supply system, an electricity distribution system, a telephone communication network, and road maintenance. Pollution monitoring and enforcement of environmental standards for the Ladkrabang IE are the responsibility of IEAT and are implemented by on-site staff. Violations of environmental regulations by factories on the estate can result in financial penalties imposed on the industrial operator and/or the issuance of an official order to cease operations until the violation has been corrected.

DESCRIPTION OF ACTIVITIES

An introductory meeting was hosted by IEAT's Environmental & Safety Control Division for the Cal/EPA team. Mrs. Kasemsri Homchean, Director of the Environmental Control & Safety Division, presented a comprehensive description of policy guidelines governing Ladkrabang's environmental administration. Mr. Napong Arriyanat, an IEAT engineer, presented an overview of Ladkrabang IE's physical organization and described the wastewater treatment plant, hazardous waste disposal/management, solid waste disposal, and air monitoring.

Mrs. Anchalee Chavanich, IEAT's Deputy Governor (Development), officially welcomed the Cal/EPA team members to Thailand and introduced the following IEAT project coordinators and other individuals assigned to work with the team:

Industrial Estate Authority of Thailand

Mrs. Anchalee Chavanich, Deputy Governor (Development)

Environmental & Safety Control Division

Mrs. Kasemsri Homchean—Director

Ms. Pattraporn Sumuntakul—Engineer

Ms. Apsornsri Samarnmit—Engineer

Mr. Napong Arriyavat—Engineer

Ladkrabang Industrial Estate

Mr. Satit Keatikumjorn—Scientist

Premier Group

Dr. Atirek Chivabongs—Presidential Advisor to Companies

Premier Products Co. Inc.

Mr. Nares Loahananta—Assistant Managing Director

Following formal introductions, a proposed work plan outlining the Cal/EPA team's activities while in Thailand was discussed. Each team member described specific information/data requirements necessary to conduct an evaluation of the industrial estate and explained how best to collect it (such as site visits, review of company environmental activities, review of sampling data, and facility process tours). The final work plan developed with IEAT staff is included as Attachment II.

Mr. Satit, who is IEAT's Environmental Scientist headquartered at the Ladkrabang IE, assisted the Cal/EPA team during a three-day site visit at the estate. Mr. Satit is responsible for monitoring environmental matters and resolving compliance issues with industry representatives. Upon the team's arrival, he provided additional details about the estate's physical features, presented an overview of the estate's operation, explained different phases of its development, described the water treatment plant and related problems associated with its operation, described the estate's solid and hazardous waste management activities, and described air pollution monitoring activities. Mr. Satit made arrangements for, and accompanied team members on, factory/plant inspections and attended meetings with company representatives. He was also instrumental as a mediator to acquire industry data for the team's review. The following facilities were visited:

- Wastewater Treatment Plant No. 1
- Wastewater Treatment Plant No. 2
- two waste incinerators (non-operational)
- Sony Magnetic Products Co., Ltd.
- Electronic Industry Company, Inc.
- Unilever Thai Holdings Limited

The following company representatives gave process/operation overviews and tours of their facilities:

Sony Magnetic Products Co., Ltd.

Mr. Thatchapong Rungruang, Safety and Environment Supervisor
Mr. Thammarong On-Wann, Manager, Human Resources

Electronic Industry Company, Inc.

Withaya Chakphet, Managing Director

Unilever Thai Holdings Limited

Apichart Intreyonk, Factory Safety and Environmental Manager
Krikchai Kim-Aree, Utility Manager

Sony Magnetic Products Co., Ltd. manufactures audio cassette tapes (11 million units per month), microcassette tapes (1 million units per month), and batteries (8 million units per month) for domestic consumption. The company molds and forms the cassette body that encloses the magnetic tape, molds and forms the protective packaging case that holds the cassette, cuts and rolls magnetic strips (tapes) into timed segments (i.e., 30-minute lengths, 60-minute lengths, etc.) from bulk rolls, and assembles the parts made on-site with parts prefabricated by suppliers into the final product for shipment: cassette recording tapes sized and timed for various applications. After the cassette body is assembled and placed into the outer packing case, the outer packing case is wrapped in a

plastic sheet imprinted with the Sony logo and product information. This final product is then boxed and stacked for shipment. The company uses large quantities of raw plastics and solvents in its plastic-molding operation where cassette bodies and protective packaging cases are formed.

Electronic Industry Company, Inc. manufactures bulk quantities of electronic parts, primarily diodes. The company sequentially processes unfinished raw materials into a final product. Large quantities of solvents are used to prepare and clean materials used to assemble the diodes.

Unilever Thai Holdings Limited makes a variety of personal care products for domestic consumption. They also have a foods division that makes ice cream. Manufacturing processes utilize significant quantities of steam that is generated by three industrial boilers that burn oil for fuel.

Following the visit to Ladkrabang, the team traveled to the city of Chiang Mai, located in Lamphun Province, to visit the Northern Region Industrial Estate. Chiang Mai is Thailand's second largest city, located approximately 600 kilometers north of Bangkok. The purpose of the trip was to provide team members an opportunity to observe the administration and operation of another industrial estate made up of different industries than ones found at Ladkrabang. Team members were accompanied by Mrs. Kasemsri of IEAT and Ms. Somchint Pilouk of her staff.

Industries doing business at the Northern Region IE are a more homogeneous collection of high-technology electronics firms. Northern Region IE staff gave a presentation to the team explaining the administrative structure of the estate, the different categorical zones in which the estate is divided, the specific types of industries conducting business on the estate, and the types of waste categories generated and how they are managed/disposed.

An interesting activity voluntarily conducted by companies doing business at the Northern Region IE is the formation of industrial associations whose membership consists of companies sharing similar industrial/economic interests. Association representatives hold regularly scheduled meetings to discuss technical/environmental issues and have a designated association official(s) assigned to work with IE staff. This activity is not practiced at the Ladkrabang IE.

The next site visit was to the General Environmental Conservation Public Company Limited (GENCO) hazardous waste disposal facility located at the Ma Ta Phut Industrial Estate. Ma Ta Phut IE is located in a coastal region of the Gulf of Thailand, approximately 100 km south of Bangkok. The area is dominated by petroleum and refining industries. GENCO is a privately owned waste disposal company that has contracted with some industries at the Ladkrabang IE to haul and dispose of hazardous

waste at their Ma Ta Phut facility. GENCO receives approximately 22,000 tons of waste per year from all clients: 19,000 tons of solid waste and 3,000 tons of liquid waste. There are 20,000 drums of liquid waste stored on site waiting for treatment and disposal. The capacity of each drum is 250 gallons.

Mr. Tanong Promma, Public Relations Manager, greeted the team and gave a brief overview of GENCO's operations. Mr. Sompong Kraivuthinundh, Plant Manager, escorted team members on a guided tour of GENCO's laboratory facilities, through an outdoor processing area where waste evaluation/categorization analysis is performed, and out to the grounds where physical waste disposal and landfilling activities are conducted.

The following day, two members visited IEAT's headquarters in Bangkok to review and compile information collected from field trips and meetings. Follow-up telephone calls were made to the Ladkrabang IE to verify observations and conclusions inferred from meetings and written materials provided during the previous week's field trips. The other two team members met with the Bangkok Metropolitan Administration regarding another Cal/EPA project. The team leader also met with US-AEP representatives and the environmental coordinator for the U.S. Embassy regarding the Ladkrabang project.

Makha Bucha Day, a religious holiday observed throughout the country, was celebrated on February 11. Team members worked on their individual portions of the report to IEAT and also participated in holiday activities.

The team spent the next day completing and integrating their individual reports into the team's official draft report to IEAT. Individual reports discussed environmental issues related to water, air, hazardous and solid wastes, and ISO 14000.

On their last day in Bangkok, team members made a formal presentation to IEAT. Members summarized their findings and presented suggested recommendations.

GENERAL RECOMMENDATIONS

Suggested recommendations, tempered by in-country experiences, were formulated in a manner believed to be considerate of Thai culture and realistic in expectations regarding attainment of goals. Based on data review, facility tours, process descriptions/demonstrations, and meetings with company representatives, the following are the team's suggested recommendations for expanding the environmental program at the Ladkrabang IE.

1. Develop an ISO 14000 Environmental Management System

Ladkrabang IE would benefit from implementation of an ISO 14000 environmental management system (EMS) as an environmental protection strategy. ISO 14000 provides a comprehensive approach to environmental problem solving by implementing an environmental management system which addresses multimedia needs.

Following the National Environmental Board's decision to require ISO 14000 implementation in the industrial estates, IEAT solicited managers of the industrial estates to determine interest in being the first to implement ISO 14000. Three industrial estate managers representing Ma Ta Phut IE, Laem Chabang IE, and Bang Poo IE volunteered. The ISO 14000 process was begun at these three estates in April 1998.

IEAT will implement ISO 14000 in partnership with the Technical Industrial Standards Institute (TISI). Other industrial estates should follow suit in the next two to three years, according to Mrs. Kasemsri Homchean.

An EMS based on consensus standards would be a suggested approach for developing a coordinated environmental management plan at the Ladkrabang IE. Adaptation of an approach reflecting cultural, business, and environmental factors as outlined in an ISO 14000 EMS would be the most realistic means of establishing a cost-effective, multimedia environmental program which is consensus oriented.

2. Establish a Working Group to Develop the EMS

A working group representing IEAT, industry, and non-governmental organizations could be assembled to develop the EMS. Their objective would be to develop an EMS for the estate that (a) identifies the effects of industrial activities and commercial products upon the environment, and (b) implements strategies for short- and long-term solutions to more effectively manage the estate.

Suggested EMS components are

- an environmental policy or mission statement for the Ladkrabang IE that affirms a commitment to, and establishes expectations for, preserving the quality of the estate's natural resources;
- agreements that establish environmental goals and objectives for meeting the expectations identified in the estate's EMS;
- a consensus plan for implementing a systematic multimedia environmental management/administrative process to meet performance standards established for the goals and objectives of the policy;
- a communication protocol between IEAT and companies on the estate;
- an information outreach program with neighborhood residents that (a) communicates environmental issues and developments occurring at the Ladkrabang IE that potentially affect them, and (b) provides a mechanism for neighborhood concerns to be expressed;
- a continuing education/training program for IEAT staff and company employees addressing current developments in environmental issues and topics;
- a scheduled review process conducted by IEAT staff to assess the EMS's performance.

3. Establish Pollution Identification and Prevention Programs

Within the context of the EMS, establish IEAT/industry agreements for implementing pollution identification and prevention programs involving community members. Based on facility tours, demonstration of process operations, and meetings with company and IEAT representatives, a suggested pollution prevention program could involve the phasing-in of (a) process modifications that improve production efficiency and reduce emissions; (b) integrating IEAT's existing infrastructure (wastewater treatment plant, waste incinerators, and landfills) into an on-site materials handling and disposal program for non-hazardous wastes; (c) installing emission control equipment to reduce air emissions from specific point sources; and (d) access to electronic databases.

Suggested elements for inclusion in a pollution identification/prevention program are activities that

- determine cost benefits for implementing pollution strategies;
- identify candidate pollutants (air, water, and land);
- determine the persistence of candidate pollutants in the environment;
- identify emission sources and emissive strengths of candidate pollutants;
- propose measures for pollution reduction/prevention;
- establish an audit program to ensure compliance; and
- adopt a consistent monitoring program that is uniformly implemented throughout the estate.

4. Establish Consensus Agreements for Ensuring Compliance

Create an assessment procedure for IEAT inspectors and industry to utilize that includes a plan to monitor for compliance. Establish pollution prevention agreements and include the assessment procedure. The auditing program should incorporate sound business and government administrative practices to

- establish an auditing protocol for IEAT inspectors and industry to follow as guidelines for conducting inspections/audits and providing information to environmental authorities;
- agree on uniform monitoring criteria to assess compliance with, for instance, performance-based standards;
- cooperatively develop reporting criteria for collecting inspection/audit information, industry notification of IEAT compliance actions, IEAT notification of industry response/action, and documentation of compliance transactions, and archiving of compliance documents;
- create a document management system to catalog and retrieve inspection/audit forms and emission data, including development of criteria to allow for public access; and
- establish a calendar of compliance milestones to assess progress towards achieving environmental goals and objectives.

5. Establish a Material Accountability Program for the Estate

Environmental management programs should encourage companies to sort, classify, and recycle non-hazardous solid wastes as a means of recovering a material's re-use value or energy content that is lost when discarded rather than

recycled. Material recycling can be a modest source of revenue generation and energy recovery while removing them from disposal operations that can potentially release more pollutants into the environment.

6. Increase IEAT Staff at the Ladkrabang Estate and Expand Training Opportunities for IEAT Staff

Increasing IEAT's Ladkrabang environmental staff can potentially have the effect of expanding environmental oversight activities conducted on the estate while providing companies more assistance in meeting their environmental responsibilities. The duties of new IEAT staff can focus on business assistance, business and community outreach, environmental program development and planning, and inspections and compliance.

A structured environmental training program (including air, wastewater, solid and hazardous waste, and ISO 14000) would be beneficial and help to cultivate the IEAT staff into a solid core of environmental experts who, in addition to fulfilling their duty to the estate, can share their expertise to help companies comply with environmental regulations.

SPECIFIC RECOMMENDATIONS

A. Industrial Estate Management Recommendations

1. Establish a clear management policy to support an environmental compliance program. A short- and long-term environmental management plan could be prepared and implemented. There must be sufficient staff that are well trained and motivated to assume these responsibilities. Staff must also be empowered to make decisions while in the field and be supported by management. Establishing a more specific environmental management policy and plan would provide an opportunity to clarify the expectations from IEAT management.
2. Prepare a mission statement and obtain the input and support from factory employees. The mission statement could include the short- and long-term goals of IEAT. Develop a strategic plan, with time frames, on how to meet the goals of the mission statement. Involve the factories and IEAT staff from the beginning in developing and implementing the action plans written to meet the goals.
3. Establish at least one environmental position for every 40 factories. Offer training and education programs for factories regarding legal obligations, pollution prevention, waste minimization opportunities, and ISO 14000. These actions would allow for more effective implementation of IEAT's environmental policies.
4. Provide in-depth training for field staff in wastewater, air, and solid and hazardous waste disciplines. Develop a professional development program (e.g., training courses, on-the-job training with experienced personnel, etc.) for IEAT staff. This would give more of the staff the opportunity to work effectively with factories by more fully understanding their processes and also allow for more effective application of IEAT policies.
5. Provide consultative services regarding environmental issues (e.g., legal requirements, pollution prevention) by utilizing IEAT staff. Conduct periodic audits (perhaps annually) at each factory involved in any of the program elements (such as air emissions, wastewater discharge and treatment, hazardous waste generation and treatment, and solid waste) to ensure environmental policies are understood and being implemented properly. Develop and implement a standardized environmental audit and compliance policy so that factories clearly understand the expectations of IEAT management and the consequences of failing to implement applicable environmental responsibilities.

6. Recognize the Ladkrabang IE managers for taking action at the factories to ensure compliance and include this task as part of the employees' performance reviews. This would provide IE managers with appropriate recognition for effectively applying environmental policies.
7. Establish centralized hazardous waste storage facilities. This would allow smaller quantity generators the opportunity to aggregate hazardous wastes in a common area until GENCO picks them up and thereby reduce the hazards of long-term on-site storage.
8. Develop a waste exchange program to encourage and promote recycling. Such a program is based on the premise that one factory's waste could be another factory's useable product. Make it cost-effective for factories to recycle used oil and used antifreeze, for example. Once the factories realize an economic benefit to recycling and exchanging wastes, they may be more receptive to participate in such a program.
9. Encourage participation in the formation of factory associations at IEs to increase communication between factories manufacturing the same products. These associations could meet on a regular basis to discuss environmental issues and potential solutions. For example, if five factories produce the same waste streams, they could coordinate the removal of their wastes, thereby decreasing transportation costs and mobile source air emissions from the transporter.
10. Develop a public participation program to allow the public to have access to information regarding materials utilized and wastes generated from factories. Such a program would also provide for public input (i.e., public hearings) on projects which may impact the environment, such as factory expansion and installation of new equipment. These actions would give the public a better understanding of IEAT operations and develop trust.
11. Implement a hazardous waste shipping (e.g., manifest) tracking program to ensure that hazardous wastes are being disposed of properly.
12. Establish regular environmental coordination meetings between senior management of the Ministry of Industry; the Ministry of Science, Technology and Environment; the Ministry of Labor and Social Welfare; the Ministry of Public Health; universities and academics; and the Bangkok Metropolitan Administration to address common environmental concerns (e.g., training and education, auditing, and compliance).

B. Wastewater Observations and Recommendations

After inspecting the two Central Wastewater Treatment Plants (WWTP No. 1 and WWTP No. 2) and three factories of the Ladkrabang IE, and reviewing their operations and monitoring reports of November and December 1997, several observations and recommendations are presented.

Water quality standards for dissolved oxygen, biologic oxygen demands (BOD), and lead were exceeded in 1997. Effluent standards for suspended solids, chemical oxygen demands (COD), oil and grease, and mercury were exceeded at WWTP No. 1; effluent standards for BOD, mercury, and nickel were exceeded at WWTP No. 2.

IEAT contracts out to BJT Water Co. to monitor wastewater operations and prepare operations reports. The operations reports prepared by BJT Water Co. also indicated shock toxic metal loads from factory discharges which interfere with treatment processes at WWTP No. 1. The reports recommended the installation of a chemical-dosing system at the primary sedimentation basin to precipitate the metals.

Recommendations to resolve this issue include developing and implementing a comprehensive pretreatment and waste minimization program to reduce the discharge of metals and other toxic pollutants from the factories to the sewer system.

The program could include

- (1) periodic sampling of the factory discharges to identify pollutants of concern that interfere with WWTP treatment processes,
- (2) sponsoring of outreach workshops so that factory managers and environmental staff understand the regulations and available wastewater treatment and waste minimization technologies, and
- (3) enforcement of pretreatment standards. Factories could be encouraged to establish trade associations which can cosponsor the outreach workshop with IEAT.

If the above programs have not eliminated toxic metals and other shock loadings at the WWTPs, then IEAT may consider installing a chemical-dosing system as recommended by BJT Water Co.

WWTP No. 2 has significant operational issues. Many unit processes were not functioning properly. Its effluent exceeded BOD standards in December 1997 because it was unable to produce and maintain sufficient biological sludge in the aeration basins. The aerobic sludge digestion basin was empty and not in use on February 3, 1998, when the team visited the plant. To restore the plant to full operation, the entire plant may have to be repaired and upgraded.

Regarding the wastewater collection system, it was reported that industrial wastewater from the factories frequently overflowed from the manholes. This indicates that either extraneous water was entering the sewer system through broken sewer lines or obstructions were inside the lines. The sewer lines should be inspected to determine their integrity. Broken sewers should be repaired to reduce infiltration of extraneous water such as groundwater and rainwater. In addition, the sewer lines should be inspected periodically to remove obstructions.

C. Hazardous/Solid Waste Observations and Recommendations

Hazardous Waste

Dewatered sludge produced at the WWTP No. 1 is transported to the WWTP No. 2 site and dumped on the land around the plant. Since rain can produce polluted runoff from these sludge piles and pollute surface waters, the sludge should be analyzed for metals and other toxic pollutants. If analytical results indicate it is not a hazardous waste, the sludge may be disposed of at a landfill. If the sludge is a hazardous waste, it will be necessary to follow proper procedures for storing, transporting, and disposing of it off-site (using a disposal company like GENCO). As a temporary measure, dewatered sludge piles could be covered with tarps to prevent rainfall from creating contaminated leachate and polluting the waterway.

There appears to be no hazardous waste management system in place. It was difficult to determine which of the many factories in this IE generated hazardous waste as there was no central data collection system. It was also difficult to determine exactly what hazardous wastes were generated, by whom, and for how long.

Recommendations include development of a hazardous waste management plan. To be most effective, the team recommends the plan include

- the type and quantity of hazardous waste generated at each factory,
- the total volume of hazardous waste generated at each factory,
- the location of hazardous waste storage, and
- storage times.

Developing a system that would show the type of waste generated by a factory and its final destination would greatly benefit IEAT.

The team observed that there is little information available about recycling and no incentive for factories to recycle their wastes. In addition, wastes appear to be stored for indefinite periods of time at some factories. Some factory representatives were unaware of the wastes they had generated, or how long they had been storing the wastes. The team recommends that each IE construct and promote the use of a centralized hazardous waste storage area. Also, IEAT could encourage facilities to take their wastes there free of charge. This could decrease IEAT's hazardous waste disposal costs since GENCO would be picking up wastes from a centralized point. (This concept would not necessarily work for large-quantity generators, but it would be helpful and cost-effective for smaller generators.)

Some factories seemed reluctant to send hazardous waste to the GENCO facility, possibly because of the disposal costs. GENCO, in conjunction with IEAT, could develop a nationwide marketing plan and strategies to encourage factories to take their hazardous wastes to the GENCO facility.

Solid Waste

Solid wastes were not being properly disposed of because the two incinerators had broken and ceased operating. At a minimum, the incinerators at the Ladkrabang IE should be repaired and operation resumed so that, even with their limited capacities, they can dispose of the solid waste. Also, the team recommends that solid wastes be segregated while at the factories. This will facilitate recycling of materials and reduce the amount and cost for disposing of solid wastes at the landfill.

The estate's two inactive incinerators installed to reduce solid wastes are undersized when compared to the amount of waste accumulated for reduction. No information about incinerator capacity could be found (either in IEAT files or "plated" on the incinerator body), but a visual estimation places the capacity at approximately 230 kilograms per hour (500 pounds per hour). In the United States, incinerators of that capacity are typically installed for a single building, such as a hospital.

The capacity of the incinerators necessary to dispose of the solid waste onsite should be expanded to accommodate the volume of waste produced. An incinerator with a capacity of 400-500 tons per day would be needed to handle the volume of waste generated at the estate. A comparison can be made to the City of Commerce in California, which is primarily made up of commercial facilities similar to Ladkrabang, where the incinerator's capacity is between 400 and 500 tons per day.

D. Air Observations and Recommendations

Air monitoring is performed at Ladkrabang (and at the Northern Region Industrial Estate) on a biannual schedule. A private environmental company, SECOT Environmental and Safety Services, with air pollution sampling experience and equipment, is contracted to collect samples at four locations on the perimeter of the Ladkrabang estate: (1) the administrative office, (2) Wastewater Treatment Plant No. 2, (3) a site near Data Products Co., Ltd., and (4) on the property of Honda Co., Ltd. These sites were selected because of macroscale meteorological conditions in the vicinity of the estate. (During winter months, the winds predominantly come from the northwest and during the summer from the southwest. This generally places the air-monitoring sites in a seasonal upwind-downwind orientation.) There is no meteorological monitoring station located on the estate.

The monitoring data is more representative of the air quality conditions in the vicinity of the monitoring sites on the specific days of sampling and testing, and not of the entire estate as implied in the report. Determining the air quality for the entire estate requires that comprehensive air-monitoring and meteorological measurements be collected.

From air-monitoring reports provided to the estate by the source-testing contractor, it appears that state-of-the-art continuous electronic analyzers and grab-sampling equipment are used to collect and analyze samples. However, this could not be confirmed by IEAT staff and verification of correct equipment application for air monitoring could not be determined from the report. In general, the contractor should

- provide IEAT staff with a more detailed report describing conditions under which samples were collected;
- refer to specific sampling/analytical methods used, field and laboratory quality assurance (QA) activities performed, and field and laboratory QA/quality control (QC) methodologies conducted;
- discuss test conditions encountered when samples were collected; and
- explain test results (including results of blank sample analysis, sample detection limits, analytical reporting limits, and analytical minimum detection levels).

Air-monitoring data does not appear to be used to support existing air pollution programs or activities which include the following:

- emissions inventory,
- modeling,
- research,
- air pollution identification and control,
- toxic air contaminant identification and control, and
- planning and strategy development for the technical and regulatory attainment of standards, or for compliance programs to encourage and confirm adherence to regulatory requirements.

The lack of data utilization may reduce the incentive to monitor or control air contaminants.

A comparison of ambient air standards adopted by MOSTE, the United States Environmental Protection Agency (US EPA), and the Cal/EPA is presented in Attachment III, “Comparison of Air Quality Standards.”

There is no active stack-monitoring program being conducted on the estate to quantify ducted emissions to the atmosphere. IEAT staff did not have information regarding pollutant emission limits for incinerators or stationary sources of emissions. Such monitoring capabilities would be necessary to support air pollution compliance, emissions inventory, control technology evaluation, and research programs for air quality goals.

Use of emission factors to calculate estimated pollutant emission rates and for establishing process operating permit conditions would be an economic alternative to conducting source tests and stack monitoring. Implementation of a material accountability program encouraging factories and plants to improve material-handling efficiency and provide accurate manifests of raw material usage can help IEAT’s staff calculate process emission rates using published US EPA “EMISSION FACTORS.”

During the factory-site visits, the team observed many sources of fugitive (unconfined) emissions of air pollutants and toxic air contaminants. These fugitive emission sources typically were

- unventilated/uncontrolled production processes (soldering, etching, and plating) using plastics and solvents for feed stock (polypropylene, solvent-based printing inks for rotary printing presses, and molding) and solvents for preparation/cleanup (methyl ethyl ketone and isopropyl alcohol);

- raw materials handling and storage areas, hazardous waste handling and storage areas, and mechanical/chemical wastewater treatment operations (hydrogen sulfide odors); and
- uncovered piles of raw production materials and solid wastes. There were no observable mitigation practices being implemented to suppress windblown dust or capture/control potential process evaporative emissions.

Of the working industrial incinerators inspected during the factory visits, all are used to reduce solid waste, burn fuel oil, and have limited air pollution control equipment installed to minimize emissions to the atmosphere. The type of solid waste accumulated for incineration and volume reduction appears to be packaging materials with high ink coverage or discarded production materials made of plastic, both of which may emit air contaminants. Cyclones for gross particulate control are the predominant emission-control device but no equipment for gaseous pollutant controls are present. Therefore, products of combustion, products of incomplete combustion (that may be generated during conditions of a thermally cold incinerator start-up), and exhaust gas components contributing to the formation of secondary particulate matter are potentially released to the atmosphere.

Sony Magnetic Products Co. Inc. plans to install an on-site incinerator for waste reduction but is waiting for an environmental evaluation from their parent corporation regarding assessments of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran emissions from waste incinerators (i.e., the destruction removal efficiency (DRE) of the incinerators).

Industrial boilers typically used on the estate to generate steam and hot water have rated energy capacities of approximately 7500 kilowatts and a steam generating capacity of about 10 tons per hour. Combustion gas effluents are monitored at the stack exhaust every three months for carbon monoxide. There is no combustion gas control equipment installed.

CONCLUSION

An environmental management system (EMS) emphasizing ISO 14000 consensus standards would be the most reasonable approach for the Ladkrabang IE to achieve environmental objectives in a culturally sensitive, efficient, and cost-effective manner. It would provide for mutual acceptance of environmental goals, acceptance of responsibility, and recognition of achievement in the environmental arena. Specifically, it would be appropriate to include a consensus-monitoring approach, an audits and inspections component, and controls and corrective actions.

Comprehensive EMS elements also include the following:

- an environmental policy,
- environmental aspects and legal requirements,
- integrated multimedia planning (i.e., establish performance targets),
- a systematic management process to meet performance targets,
- training and communication procedures, and
- management review and documentation.

Specific Cal/EPA Proposed Actions

Specific follow up actions by Cal/EPA could include the following:

- Providing training in wastewater treatment, hazardous and solid waste issues, air issues, and ISO 14000 implementation. The Cal/EPA team was invited by IEAT to return to Thailand and provide such training. Another option would be to send IEAT staff to California to learn more about the environmental management process in California.
- A technology trade mission to Thailand with a Cal/EPA Team representative as a facilitator. California companies could provide appropriate environmental technologies for IEAT as well as individual factories to upgrade currently provided services and processes. This could include provision of operation and maintenance packages to utilize at the IEs (such as repairing and operating the incinerators, and re-mediating the wastewater treatment issues).

ATTACHMENT I

MEMORANDUM OF UNDERSTANDING WITH THE INDUSTRIAL ESTATES AUTHORITY OF THAILAND

ATTACHMENT II

WORK PLAN FOR THE LADKRABANG INDUSTRIAL ESTATE REMEDIATION PROJECT

WORK PLAN FOR THE LADKRABANG INDUSTRIAL ESTATE REMEDIATION PROJECT

Monday	February 2	1000 - 1200	IEAT Headquarters Meeting with Project Coordinators
Tuesday	February 3	0900 - 1630	Ladkrabang IE
Wednesday	February 4	0900 - 1630	Ladkrabang IE
Thursday	February 5	0900 - 1630	Ladkrabang IE
Friday	February 6	0700 - 1700	Northern Region Industrial Estate, Chang Mai
Saturday	February 7	0700 - 1700	Return to Bangkok
Monday Estate	February 9	0700 - 1900	GENCO, Ma Ta Put Industrial
Tuesday	February 10	0900 - 1630	IEAT Headquarters Documentation Review and Report Preparation
Wednesday	February 11		Public Holiday
Thursday	February 12	0900 - 1630	IEAT Headquarters Report Preparation
Friday	February 13		Presentation

ATTACHMENT III

COMPARISON OF AIR QUALITY STANDARDS

COMPARISON OF AIR QUALITY STANDARDS

<u>POLLUTANT STANDARD</u>	<u>MOSTE</u>	<u>U.S. EPA</u>	<u>STATE OF CALIF</u>
Particulate Matter (24 hour)	TSP 0.33 mg/cu.m.	PM-10 150 ug/cu.m.	PM-10 50 ug/cu.m.
Ozone (1 hour)	0.2 mg/cu.m. (200 ug/cu.m.)	160 ug/cu.m. (8 hour)	180 ug/cu.m.
Nitrogen Dioxide (1 hour)	0.32 mg/cu.m. (320 ug/cu.m.)	100 ug/cu.m. (annual ave.)	470 ug/cu.m.
Sulfur Dioxide (24 hour)	0.3 mg/cu.m. (300 ug/cu.m.)	365 ug/cu.m.	105 ug/cu.m.
Carbon Monoxide (8 hour)	1 0.26 mg/cu.m. (10260 ug/cu.m.)	10 ug./cu.m.	10 ug/cu.m
Lead (30 day ave.)	———	1.5 ug/cu.m. (calendar quarter)	1.5 ug/cu.m.
Hydrogen Disulfide (1 hour)	———	———	42 ug/cu.m.